

OBSERVATIONAL MEDICAL OUTCOMES PARTNERSHIP

Partnership Update

Current Outlook

The Observational Medical Outcomes Partnership (OMOP) was funded as a two-year program of work designed to develop, implement, and empirically test the performance of analysis methods in identifying drug outcomes across multiple observational data sources. The goal of this work was to inform the implementation of a systematic surveillance system with empirical evidence of the appropriate methods, data, and infrastructure necessary to identify and track potential relevant safety issues (and, to a lesser extent, drug benefits). The OMOP collaboration has underscored the importance of understanding the effects of a drug in the real world as reflected by administrative claims and electronic health records data. OMOP is one of the most ambitious initiatives in the field and has researched and developed key data, infrastructure, methods, and governance topics through open scientific collaboration.

The OMOP research team is on track to complete the OMOP research agenda as initially planned. All Phase 1 and 2 deliverables are complete and Phase 3 is well underway. Beyond the insights that have arisen from the execution of the research plan, the research team has also developed a series of enabling technologies that have facilitated the Partnership's methodological research; these technologies are publicly available for use by the broader research community.

This includes the definition and implementation of a Common Data Model (CDM) and a standardized vocabulary to facilitate research across a diverse network of data sources, design, and infrastructure for a central coordinating center and distributed network of healthcare data partners, standardized procedures for analysis methods developed by a cross-disciplinary community of methods collaborators, systematic tools to characterize and assess data resources for observational analysis, a systematic approach to defining and implementing Health Outcomes of Interest (HOI), and tools to generate simulated healthcare data sets to support validation of analytical methods. Visit the OMOP website for more details on the tools and instructions on how to access them for use within your organization.

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While the first year of OMOP was about building and preparing, the second year of the project plan is about fully characterizing our central and distributed data sources, running the core experiments to assess methods, analyzing results, and preparing papers and reports. The methods team is continuing to develop and refine analysis methods and we are working on a second-

generation data simulator. Already, OMOP investigators, including scientists at our distributed data partners, are gaining insights into the variability of results from one data source to another. As with most research projects, OMOP is generating new questions about observational data and analysis methods. Some of these questions are being tackled now, while others are future research opportunities.

Table 1. OMOP Key Deliverables

Key Goal	What We Have Delivered
Establish OMOP research community	<ul style="list-style-type: none"> • Built the OMOP Research Lab which serves as a central coordinating center hosting the CDM, research data, and analysis methods • Established distributed network of Data Partners (6) • Launched Extended Consortium • OMOP Methods Collaborators (17) • Hosted OMOP Cup with 60+ participants • Created OMOP website with 1000+ registered users • 2009 Symposium with 300+ attendees
Establish a consistent framework to use across disparate observational data sources	<ul style="list-style-type: none"> • CDM • Standardized terminology specifications • CDM reference tables that contain the standardized terminologies and mapping from source vocabulary • ETL specifications for all data partners • GE Centricity and Thomson ETL source code • Generalized ERA logic developer
Develop and test analysis methods within the OMOP Research Lab and other data environments	<ul style="list-style-type: none"> • Overview of methods (methods to consider and inventory matrix) • 14 methods specifications and source code • Observational Medical Data Set Simulator (OSIM) - specification, source code, and data sets
Establish standard data characterization and facilitate comparisons across databases	<ul style="list-style-type: none"> • Data screen and assessment questionnaires • Observational Source Characteristics Analysis Report (OSCAR) Specification and Source Code • Natural History Analysis (NATHAN) Specification and Source Code • Generalized Review of OSCAR Unified Checking for data quality and validation analysis
Implement HOI definitions	<ul style="list-style-type: none"> • HOI definition process (literature review strategy, evidence table) • HOI process outputs for 10 HOIs • 35 definitions for 10 HOIs • Regularized Identification of Cohorts (RICO) program to implement HOI definitions within CDM
Public-private partnership governance model with engagement of Executive and Advisory Boards	<ul style="list-style-type: none"> • 10 Executive Board members, chaired by FDA and managed by Foundation for NIH • 21 Advisory Board members • 6 research investigators and FNIH Program Management Office

OMOP Announces Cup Winners

OMOP Cup Challenged Contestants to Develop Algorithms to Improve Drug Safety

Improvement of drug safety and the identification of adverse drug events remains a challenge to a large number of constituencies. Several recent drug safety events have highlighted the need for new data sources and algorithms to assist in identifying adverse drug events in a more timely, effective, and efficient manner. The methods and statistical tools used on large healthcare data sources (e.g., administrative claims and electronic health records) have been lacking and are not yet systematized to look at disparate databases. The Observational Medical Outcomes Partnership (OMOP) conducted a Methods Cup Competition as a catalyst for new methods development to identify relationships in data between drugs and adverse events.

The competition started in September 2009, and quickly built a community generating new ideas. OMOP provided the participants with a large simulated data set resembling healthcare data that was “spiked” with adverse events. The competitors had to find the signals by generating methods to identify relationships in the data between drugs and medical outcomes (adverse events). The goal was to develop methods that correctly identified true drug-event associations while minimizing false positive findings. Methods were evaluated by how closely they predicted the known relationships that existed in the data. Prior to the competition, which closed on March 31, 2010, there were over sixty competitors from many fields and entities.

Description of Methods Problem

Methods determine the relationship between drugs (medications) and conditions or health outcomes (potential adverse events). Identification of such associations aims to generate hypotheses from observational data by identifying associations between drugs and conditions for which the relationships were previously unknown. This is likely to be considered an initial step of drug monitoring, where many drug-condition pairs are simultaneously explored to prioritize the drugs and outcomes that warrant further attention. The high number of possible combinations represents a large computational challenge.

For observational analyses, it is important to recognize that the goal is to provide information about associations between drugs and outcomes across a population of interest. The intended objective is not necessarily to conclusively ascertain whether a specific person had a particular outcome due to a particular drug, but instead to infer whether a population of individuals exposed to a product experiences more of the outcome than otherwise expected had they been unexposed. This population-based approach differs from the spontaneous adverse event reporting systems, which consider each data record a specific self-report of a suspected causal association between a drug and an event. For this competition, OMOP required methods that are computationally feasible, incorporate information of known drug-condition associations, and identify associations from observational data as accurately as possible.

Data Description

For the competition, OMOP provided a data set of hypothetical records for competitors to use in creating their analysis methods. The simulated data set contains more than one million persons, more than ten million drug exposures from four thousand unique drugs, and more than ten million condition occurrences from five thousand unique conditions over a span of three years. For a small subset of the twenty million possible drug-condition combinations, there exists a true causal association between the drug and the condition. We assume that the strength of the causal association remains constant over time. For the remaining combinations, no causal association exists.

Competition Description

The OMOP Methods Cup Competition had two challenges and participants were encouraged to compete in either or both challenges.

Challenge 1: Identifying drug-condition associations within an entire observational data set.

There is great interest in finding relationships between drugs and adverse events through retrospective exploration of existing observational databases. Methods that can correctly classify drug-condition relationships as true or false associations could greatly contribute to the current pharmacovigilance practice by providing all key stakeholders additional information to inform therapeutic decision making. This challenge sought analysis methods that, given an observational database containing multiple different types of drugs and conditions, can identify the relationship between all drug-condition pairs.

Challenge 2: Identifying drug-condition associations as data accumulates over time.

Timely detection of drug-related adverse events as part of an active surveillance system would allow patients and providers to minimize potential risks and inform their therapeutic decision making as quickly as possible. This challenge evaluated methods performance in identifying true drug-condition associations and discerning from false association as data accumulated over time.

Competition Process

Participants (teams or individuals) initially registered on the competition website where a real-time leader board could be monitored. In addition, participants completed a disclosure agreement allowing submitted information to be placed in the public domain in keeping with the policies of the partnership. Each challenge had a cash prize for the first and second place winners. The total amount of prize money available was twenty thousand dollars. Each winning participant submitted a technical report on the method used as well as the source code.

The first challenge rewarded best overall performance, while the second looked at performance over time, as data accumulated. Entries were scored on how accurately they distinguished between true drug-event relationships and the negative controls. Although only U.S. competitors were eligible for prizes, individuals and teams from around the world—sixty-nine in all—participated in the challenges. Twenty-one beat OMOP’s own internal benchmarks.

The screenshot shows a web browser window with the URL <http://omopcup.orwik.com/announcements>. The page title is "2009/2010 OMOP Cup: Methods Competition" and it shows 0 publications and 73 followers. The navigation menu includes Home, People, Announcements, Challenges, and Discussions. The main content area displays two announcements:

- OMOP Cup closed for submissions** (Public): The deadline for entries to the OMOP Cup has passed. The leaderboard shows unofficial results, and we will be working to determine the winners of each competition in the days to come. Thanks very much to everyone who participated, and stay tuned for more information about OMOP's next steps.
- Last day for submissions** (Public): The competition is closing at midnight Eastern daylight time tonight. If you have any problems submitting, email omopcup@gmail.com and we'll work to remedy the situation.

Below the announcements is the **Challenge 1 Leaderboard** (Public), which contains the following table:

User	Best Score	Last Score	Last Submission
Martijn J Schuemie	0.2662359	0.2662359	2010-03-31 23:24:58
David S Vogel	0.2570616	0.2555797	2010-03-31 23:15:03
Hawkeye DORP	0.2569417	0.2569417	2010-03-31 23:52:33
Mohammad Khoshneshin	0.2569404	0.2569404	2010-03-30 23:50:18
Nick Street	0.2568678	0.2568678	2010-03-31 01:43:59
Craig G Carmichael	0.2483813	0.2483813	2010-03-30 23:32:47
Harris T Lin	0.2483137	0.2482600	2010-03-28 20:12:35
girishkumar ramesh sabhnani	0.2358521	0.2358521	2010-03-31 20:19:04

Success

After two months of entries, the OMOP Methods Cup Competition reached its first milestone with the Progress Prize. Four awards totaling five thousand dollars were awarded to participants who produced the highest-performing methods that improved the state-of-the-art identification of adverse drug events in medical records. The cross-disciplinary competition brought together competitors from epidemiology, drug safety, statistics, and machine learning.

The winners of the Progress Prize for the first challenge are David Vogel and Eric Gottschalk of Data Mining Solutions, with \$2,500 in prize money. Robin Sabhnani of Carnegie Mellon University won \$1,000 for second place. Challenge 2 evaluated the timeliness of detection of drug-event associations by having methods run against data sequentially as it accumulates over time. Robin Sabhnani was in first place, receiving \$1,000. Lisa Friedland of the University of Massachusetts at Amherst took home \$500 for second place.

The leader at the end of the competition in March 2010, and official winner of the \$10,000 prize for Challenge 1 was David Vogel of Data Mining Solutions. A University of Iowa health informatics team comprising Lian Duan, Mohammad Khoshneshin, Si-Chi Chin, and Nick Street won the \$5,000 prize for Challenge 2. Despite the fact that only U.S. competitors were eligible for prizes, there was a number of international submissions, including the top-performing methods for both challenges. Martijn Schuemie of Erasmus University in the Netherlands developed the top-performing method for Challenge 1. The top-performing method for Challenge 2 was developed by Vladimir Nikulin of the University of Queensland, Australia.

“The competitors applied an extraordinarily diverse set of technical approaches, and many of their novel ideas may well represent important new directions for methods research in this area,” said David Madigan, Professor of Statistics at Columbia University and an OMOP Investigator. The approaches from the four winners included binary prediction modeling, random forest, two-stage disproportionality (IC), ensembling of two disproportionality methods plus the Poisson method using exposure times and matrix factorization and calibration.

Table 2. OMOP Cup Competition Winners

	Challenge 1	Challenge 2
Progress Winners	David Vogel and Eric Gottschalk, Data Mining Solutions	Robin Sabhnani, Carnegie Mellon University
	Robin Sabhnani, Carnegie Mellon University	Lisa Friedland, University of Massachusetts Amherst
Final Winner	David Vogel, Data Mining Solutions	University of Iowa Health Informatics Team
Highest Performing Methods*	Martijin Schuemie, Erasmus University, Netherlands	Vladimir Nikulin, University of Queensland, Australia

* Only United States competitors were eligible for prizes.

Importance and Value of Exploratory Analysis

OMOP's Methods Implementation

The Observational Medical Outcomes Partnership (OMOP) has implemented fourteen methods for the OMOP Common Data Model (CDM) under several categories: a) disproportionality analysis b) case-based c) exposure-based d) sequential and e) other methods. The OMOP community is composed of individuals and organizations with significant experience in methods development and implementation using various epidemiological statistical methods on observational databases. OMOP has leveraged this knowledge base to take these methods (and their permutations) on an exploratory journey into the world of post-market active surveillance, and to use an empirical approach to identify optimal methods and settings to test drug-condition associations.

Generally, OMOP is looking at a broad collection of methods with different approaches and evaluating the approaches to determine how well the methods discriminate between the true association and the false associations on the different databases. This evaluation will generate substantial results. There is no expectation that we will find the “magic bullet” as we expect we will see different approaches working well in different kinds of situations.

Each method has multiple parameters that can be used to tailor the analysis for a particular drug-condition relationship. An objective of the OMOP research plan is to empirically evaluate the performance of each analysis (meaning a method with a given parameter setting) in its ability to identify known drug safety issues and to minimize false positive findings across a network of disparate observational data sources. Dr. Zorych, an OMOP methods collaborator from Columbia University, is working on the Bayesian Logistic Regression method. He stated that “...working with observational data in which there is a temporal relationship is more complicated as opposed to spontaneous reporting analysis.” He added, “There are advantages and limitations of the methods that are being used in the OMOP work to find some effects; for example, will a particular method with specific parameters be able to find rare events?” The specific set of parameters and description of the method

is provided with each method release (go to <http://omop.fnih.org/MethodsLibrary>).

Methods collaborators are working with the OMOP research team to evaluate what drugs are associated with what outcomes or conditions. Methods are assessed within three different experiments within the OMOP community that has been standardized on the OMOP CDM. This is crucial for the methods experiments to allow for seamless execution against the various data environments. The three experiments are

- ◆ Monitoring Health Outcomes of Interest (HOI): Methods are applied to a data source to provide an estimate of the association between a drug and a defined HOI. Ten drugs of interest and ten HOI were selected.
- ◆ Identification of Non-Specified Associations: Methods are applied to a data source to provide an estimate of the association between a drug and an outcome, as defined by condition observations, rather than pre-defined HOI criteria.
- ◆ Performance against Simulated Data: A simulator is (<http://omop.fnih.org/OSIM>) conforming to the CDM in which we have applied specific signals. Methods will be implemented in the simulated data in which the ground truth (drug-outcome associations, causality) is explicitly defined.

Dr. Andrew Bate, Pfizer, Senior Director, Quantitative Epidemiologist and OMOP Scientific Advisory Board member, has been working with the OMOP Research Team on the implementation and evaluation of the Disproportionality method. As part of the OMOP experiments, for example, the Disproportionality program is being applied within the HOI experiment. Across the OMOP community of ten data sources, the Disproportionality program will be executed under 112 different parameter settings. Each configuration will produce a drug-condition estimate for each of the 213 test cases. For Disproportionality alone, the OMOP team will have $10 \times 112 \times 213 = 238,560$ rows of data, each uniquely identifying the data source, method

configuration, drug, and HOI, and providing a score to evaluate relative to the status of the drug-HOI relationship.

Dr. Bate, along with a number of OMOP methods collaborators, presented at the 33rd Annual Midwest Biopharmaceutical Statistics Workshop. Dr. Bates indicated in his presentation, "...the OMOP experiments demonstrate in both real world data and simulated data that measures of disproportionality can highlight findings of interest; albeit buried in large numbers of false positive findings. A major challenge is how to find the 'gold' amongst the 'noise'." Further work is also needed to determine whether the metrics have the potential to highlight emerging issues early, and help us to understand how best to collapse the richness of longitudinal data into an appropriate form for effective Disproportionality analysis. Such methods provide a straightforward and transparent method to the potential identification of adverse events in longitudinal data, and this allows us to readily examine how implementation choices can impact results.

Stephanie Reisinger of ProSanos Corporation has been working with OMOP not only on methods (Observational Screening) but also on the development of the observational medical data set simulator known as OSIM. Ms. Reisinger stressed the importance of "...starting now to discuss and implement systematic observational analysis by taking one method and applying [it] across the OMOP community. It is all about the application of analytic methods to disparate observational databases without requiring custom programming at the sites."

Dr. Alan Brookhart, a methods collaborator from the Department of Epidemiology, University of North Carolina at Chapel Hill, discussed the challenges of drug safety surveillance and the new user design (incident user design + propensity score methods) as a promising tool to address many of these challenges. "The new user design has well-known theoretical strengths. However, the optimal implementation of the approach for drug safety surveillance is unclear. In working with OMOP, I am exploring these issues." Dr. Brookhart speculated that many of the known drug safety issues might be fairly easy to identify. "We are screening a lot of drugs and outcomes, so I think the key will be ruling out false signals. I am excited to see the results of how the new user design method will work in the OMOP community."

Once all results are produced, the OMOP research team will conduct a series of analyses (the evaluation phase) to inform the appropriate use of the methods and data sources for identifying the known drug safety issues. Research team member Dr. Madigan stated in summary, "We will have a results data set of billions of observations. Making sense of this is [a] huge challenge and we are bringing to bear state-of-the-art visualization and summarization techniques so we can extract as much knowledge as possible to inform future active surveillance efforts."

Methods Used by OMOP

Disproportionality Analysis

1. Disproportionality analysis (DP)
2. IC Temporal Pater Discovery (ICTPD)

Case-based Approaches

3. Multi-set case control estimation (MSCCE)
4. Case-control surveillance (CCS)
5. Univariate self-controlled case series (USCCS)
6. Case-crossover (CCO)

Exposure-based Approaches

7. Observational screening (OS)
8. High-throughput screening by Indiana University (HSIU)
9. High-dimensional propensity score (HDPS)

Sequential Methods

10. Maximized sequential probability ratio test (MaxSPRT)
11. Conditional sequential sampling procedure (CSSP)

Other Methods

12. Bayesian logistic regression (BLR)
13. Statistical relational learning (SRL)
14. Incident user design (IUD)

Multifaceted Operations, Multiple Locations, and One Objective

Lessons Learned about Participating in a Distributed Model

The Observational Medical Outcomes Partnership's (OMOP) design called for the establishment of a distributed network of healthcare data organizations. OMOP has established a network of Distributed Research Partners that represent healthcare organizations that have electronic health records and insurance claims databases that are actively used to evaluate and track safety of drugs and medical products. In establishing this network, OMOP had exposure to the challenges of organizing a diverse and disparate data community. OMOP is developing an understanding of the importance of project management and shared accountability, collaboration and communication across the community, clarity of scope and specifications, and the development and management of content, tools, and results.

Both Judy Colecchi, Project Manager/Analyst, and Shawn Murphy, MD, PhD, Principal Investigator (PI) from Partners Healthcare System (PHS), an OMOP Distributed Research Partner, highlighted their lessons learned to date based upon their progress made with the OMOP methods and data experiments.

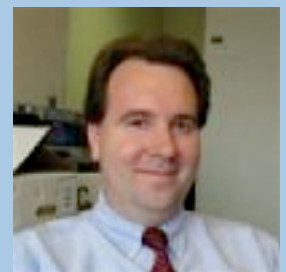
Project Management and Shared Accountability

Keen project management, both technical and operational, proves to be critical to the operation of a distributed model. OMOP team members facilitate monthly webinars with all of the Distributed Research Partners to share insights and challenges. Judy Colecchi explained, "It is the OMOP program management team and principal investigators that have the 'lens' on the project and can identify similarities or differences across the distributed sites, which improved upon our solutions and rapid responses to issues." Additionally, the OMOP team speaks on a weekly or bi-weekly basis with each individual Distributed Research Partner to discuss specific problems faced by the individual team. According to Ms. Colecchi, project management "...is critical with regards to troubleshooting and enabling the ... Partner to be

coordinated with other sites and to be aware of when we may have wavered off the path potentially due to local decision making or hardware issues."

Collaboration and Communication Across the Community

A key learning from OMOP's approach to a distributed model is the importance of collaboration and communication across the Distributed Research Partners. As indicated above, the monthly, across-site project management calls allowed all the Distributed Partners to share accomplishments and issues on the project thus far. This type of collaboration allowed the OMOP team to identify and address issues and process problems. For instance, the need to assess possible differences in data related to sites that have enrollment dates and those that do not was identified. These types of findings led to the creation of the analytic Common Data Model (CDM) for the Distributed Research Partners where this issue would have impacted analysis. Dr. Murphy stated, "This was a very important methodological adjustment that was identified at the distributed level but quickly resolved with PI oversight from each site and coordination with the OMOP research team. If this had not been identified when it had, it could have caused major analytical questions downstream with regard to looking at results across a distributed model."



Shawn Murphy, MD, PhD, Partners Healthcare Systems, OMOP Principal Investigator



Judy Colecchi, Partners Healthcare Systems, Project Manager/Analyst

Clarity of Scope and Specifications

Upon project initiation, OMOP provided a model and experiments for the Distributed Research Partners, identifying a common starting point for data preparation and the gathering of the following components:

- ◆ Data characteristics at overall and individual levels (OSCAR and NATHAN)
- ◆ Consistent identification of Health Outcomes of Interest and Drug Outcomes of Interest (for cohort and outcome definitions)
- ◆ Common methodology for creating and identifying Condition and Drug Eras, and consistent approach for measuring drug exposure testing (in the OMOP Lab) of the statistical analysis methods and availability of the performance time benchmarks

Dr. Murphy used these components to prepare PHS for OMOP Phase 1 and 2 and will continue to refer to the benchmarks as PHS makes it way through Phase 3's methods execution process. Dr. Murphy observed, "[These components] identified factors that we needed to adjust in preparation for Phase 3. For example, OSCAR analysis identified [the need] to review our mappings for combination drugs. This impacted our [Health Outcomes of Interest] and [Drug Outcomes of Interest] calculations, which we also refined."

Development and Management of Content, Tools, and Results

Each Partner had to think through what OMOP was asking as OMOP was not providing out-of-the-box capability with respect to OMOP tools in relation to the CDM. When working with a distributed model, it is important to be clear about the semantic meaning of data fields, as well as the context in which they are being used.

Ms. Colecchi shared with OMOP one of these challenges faced by PHS. PHS found that when using the CDM, the fields for payer data did not apply, since PHS did not have payer data. Therefore, PHS populated these particular fields with a NULL value. Unfortunately, as these fields are included in parts of the analytic methods, during analysis the script evaluated these fields, recognized the NULL value, and thus excluded all patients from the analysis. Ms. Colecchi revealed PHS's problem-solving strategy: "Our approach was to change the methods script to not exclude patients where the value was NULL...This was an important lesson for us for Phase 3."

OMOP's Distributed Research Partners continue to reveal valuable lessons about working with a distributed model. The initial insights regarding project management and shared accountability, collaboration and communication across the community, clarity of scope and specifications, and the development and management of content, tools, and results have allowed the project to move effectively through the first two phases and set a good foundation for Phase 3. OMOP will use these lessons to inform future projects on the operation of an electronic distributed network.

OMOP Website

<http://omop.fnih.org/>

As a public-private partnership, OMOP was chartered to foster transparency and open innovation by making its research plans, white papers, specifications, software tools, and peer-reviewed results available to the public. The OMOP Website is one of several vehicles the partnership is leveraging to fulfill this requirement. As of June 2010, the OMOP website has over 1,000 subscribers who can access OMOP research materials. Since November 2009, over 7,000 downloads were processed through the website for OMOP-produced materials. Table 3 summarizes the top ten documents downloaded during the month of May. The OMOP website is the home of the OMOP Methods Library and HOI Definitions Library. It also contains the details on the OMOP Common Data Model and the OMOP Vocabulary Specifications.

The website is a source of OMOP news, announcements, and presentations and videos.

More recently, the website expanded to support the OMOP Extended Consortium, including forums.

Subscribing to the website is easy, just complete the contact information requested and a member of the OMOP Program Management team will activate your account.

To get up-to-date news on OMOP, access and download OMOP documents, and learn more about the partnership, create an account today at <http://omop.fnih.org/user/register>.

Table 3. Top Ten Document Downloads

1. CDM Specification V2.0
2. ETL Mapping V2.0
3. Disproportionality Analysis Method Specification
4. OMOP Methods Development Guidelines
5. Standard Vocabulary Specification V2.0
6. HOI Definitions
7. Bayesian Logistic Regression Specification
8. RICO SAS
9. Disproportionality Analysis Method Source Code and Examples V2.0
10. Bayesian Logistic Regression SAS Source Code

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Upcoming Events

16th World Congress of Basic and Clinical Pharmacology :

July 19, 2010

Copenhagen, Denmark

ISPE 26th Annual Meeting:

August 19-22, 2010

Brighton, UK

Asian Conference on Pharmacoepidemiology

October 29-31, 2010

Tokyo, Japan

Joint Statistical Meeting 2010 :

July 31 – Aug 5, 2010

Vancouver, BC

DIA Conference for Biomedical

Informatics:

October 13-14, 2010

National Harbor, MD



In May 2010, OMOP collaborators attended the 30th Annual Midwest Biopharmaceutical Statistics Workshop.

From left to right standing: Stephanie Reisinger (Prosanos), Patrick Ryan (OMOP/GSK), Lingling Li (Harvard Pilgrim), Changyu Shen (Indiana University), Ivan Zorych (Columbia University), David Madigan (Columbia University), Kwan Hur (Veterans Affairs), and Andrew Bate (Pfizer). Seated: Xiaochun Li (Indiana University) and Andrea Cook (Group Health Research Institute).

Who We Are

OMOP Personnel

Program Management:

Thomas Scarnecchia, Executive Director

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OMOP Newsletter

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